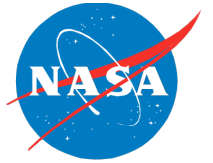


# Latest Forecast Impact Experiments Assimilating Quality Controlled AIRS Version 5 Temperature Profiles

**Joel Susskind**
**NASA GSFC Sounder Research Team**

**and**

**Oreste Reale**
**UMBC**

## NASA Sounder Science Team Meeting

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**Greenbelt, Maryland**

# Objectives of AIRS/AMSU

**Provide real time observations to improve numerical weather prediction**

Could be $\hat{R}_i$ (used by NCEP, ECMWF) or T(p), q(p)

Accuracy of $\hat{R}_i$, T(p), q(p) degrades slowly with increasing cloud fraction

There is a trade-off between accuracy and spatial coverage

Using soundings or radiances only in clear cases limits utility of the data

**Provide observations to measure and explain interannual variability and trends**

Must provide good spatial coverage but also be unbiased

Can be less accurate than needed for data assimilation

Must not contain systematic data gaps in certain regions

AIRS Version 5 contains accurate error estimates $\delta\hat{R}_i$, $\delta T(p)$, and $\delta q(p)$

Error estimates and quality flags provide options for use in either weather or climate applications

# Methodology Used for V5 T(p) Quality Control

Only cases with successful IR/MW retrieval are used

Define a profile dependent pressure, $p_{best}$, above which the temperature profile is flagged as acceptable for data assimilation and process studies

Use error estimate $\delta T(p)$ to determine $p_{best}$

Start from 70 mb and set $p_{best}$ to be the pressure at the first level below which $\delta T(p) >$ threshold $\Delta T(p)$ for 3 consecutive layers

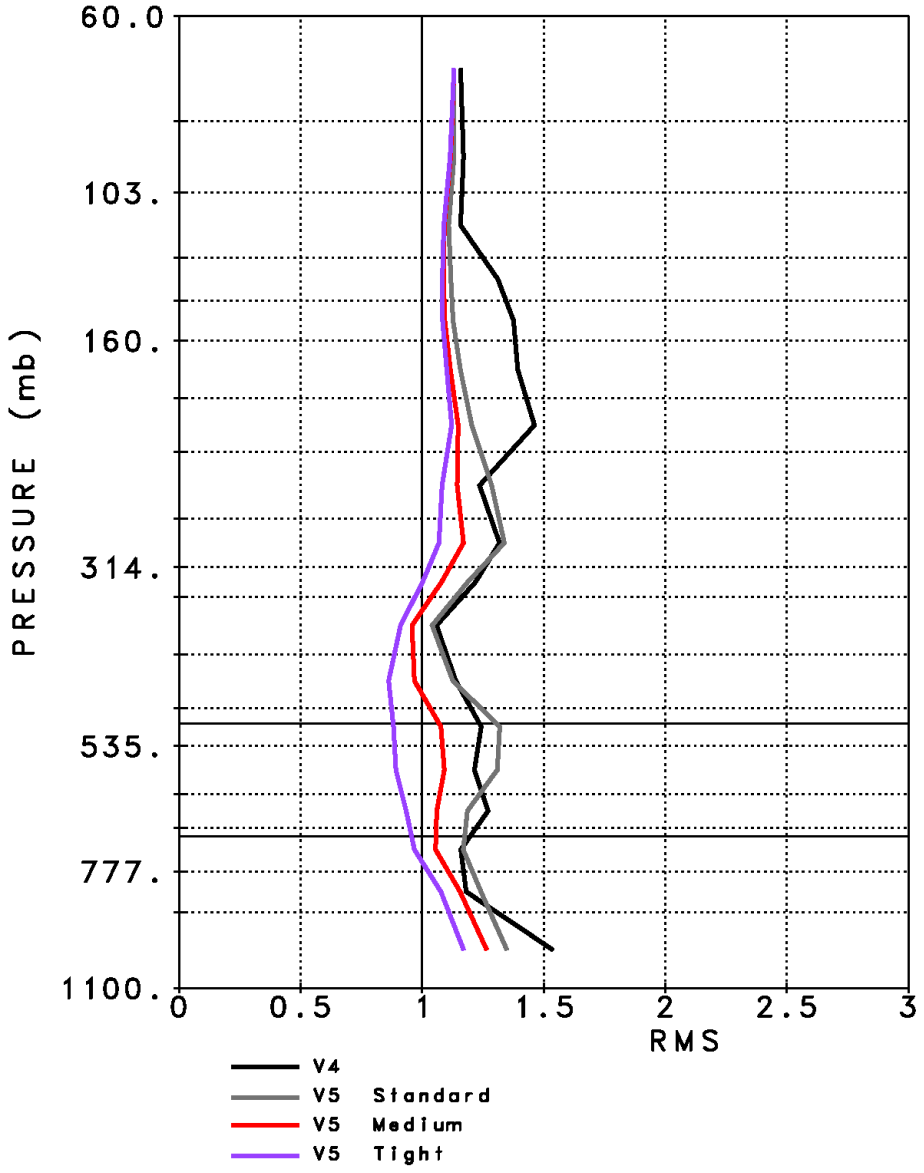
Temperature profile statistics include errors of T(p) down to $p = p_{best}$

Version 5 uses Standard thresholds $\Delta T(p)$ optimized for weather and climate simultaneously

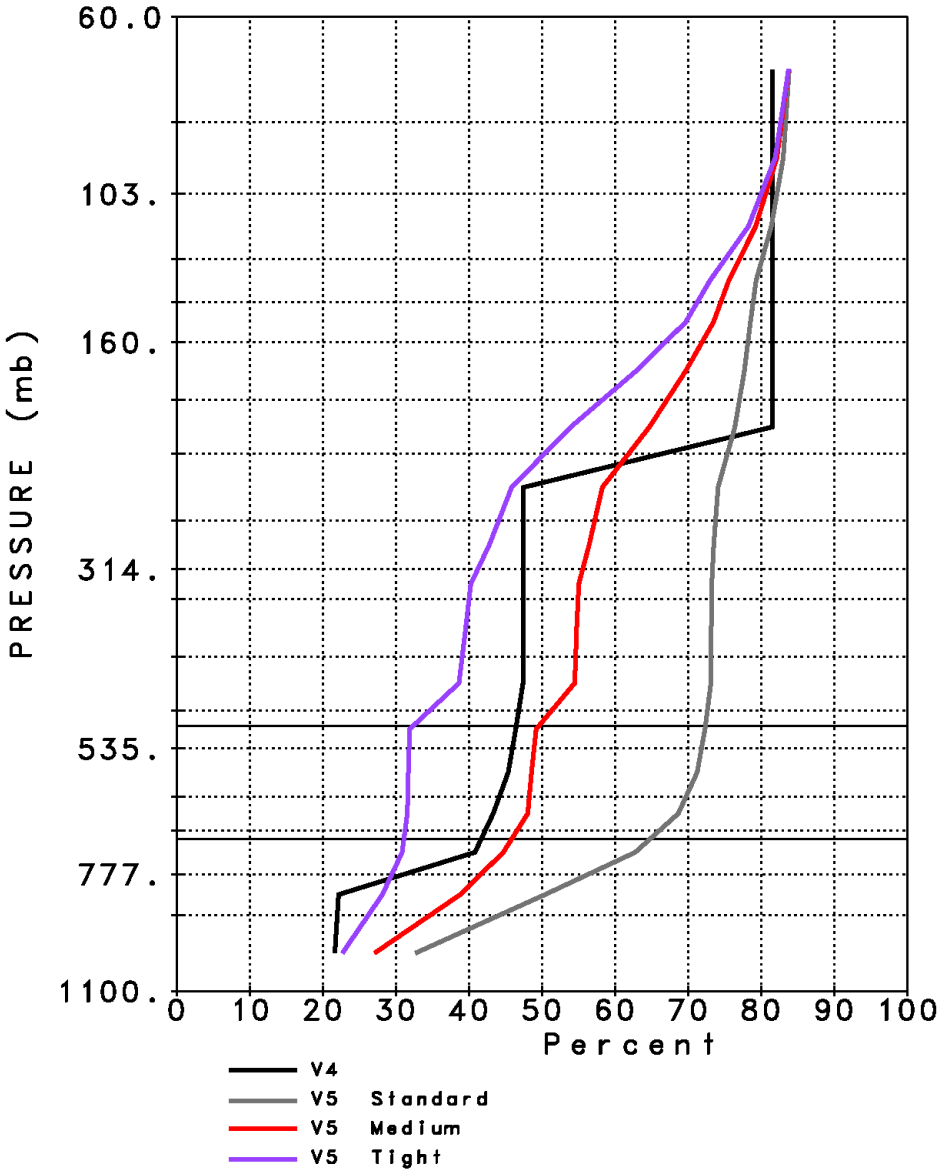
We have done forecast impact experiments with other thresholds: Medium and Tight

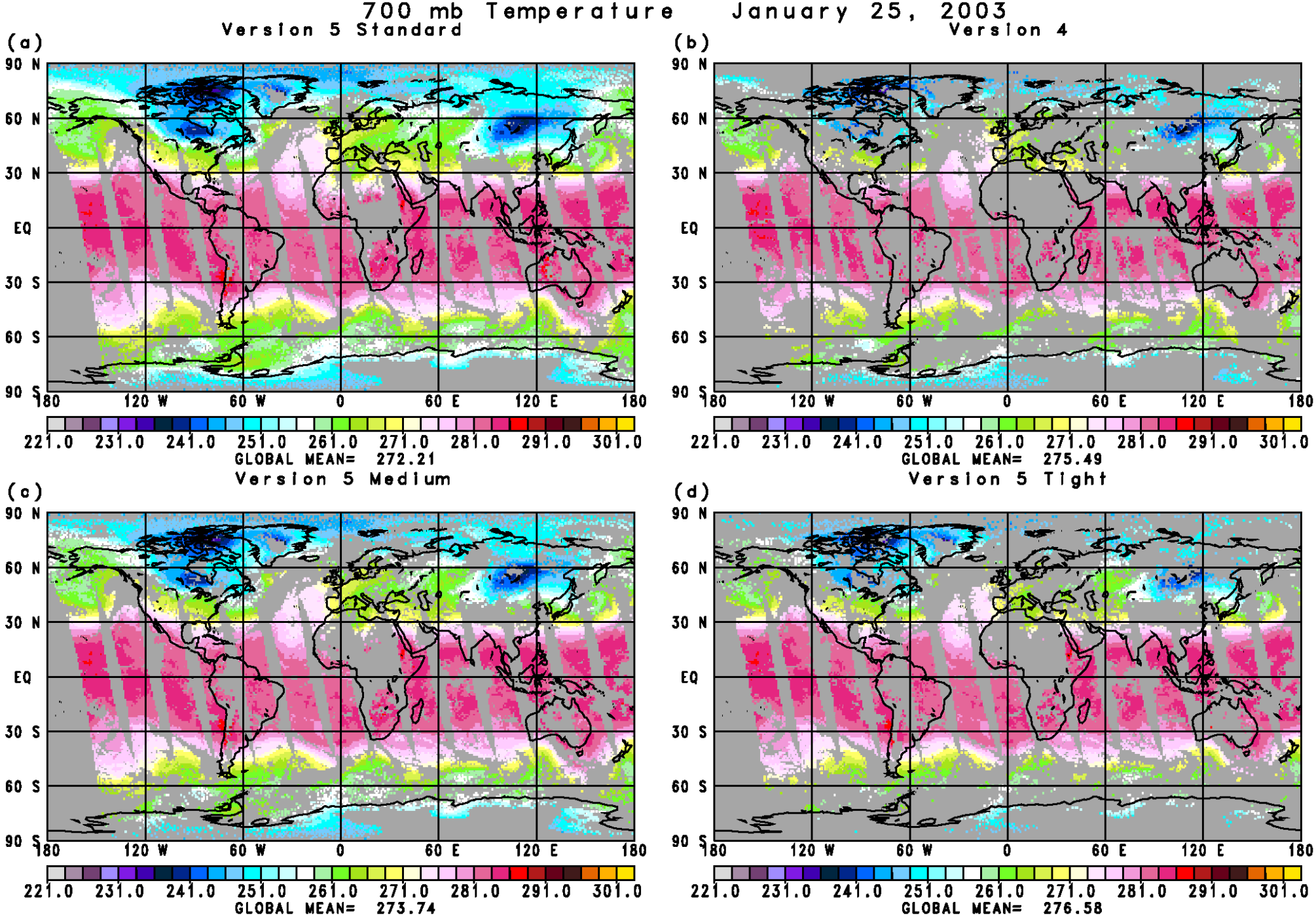
Purpose is to assess trade-off between spatial coverage and accuracy in data assimilation

Layer Mean RMS Temperature (°C)
Global Differences from ECMWF
January 25, 2003
Global




Percent of all Cases Included
January 25, 2003
Global




700 mb Temperature January 25, 2003
(a)
Version 5 Standard
90 N
60 N
30 N
EQ
30 S
60 S
90 S
180 120 W 60 W 0 60 E 120 E 180
221.0 231.0 241.0 251.0 261.0 271.0 281.0 291.0 301.0
GLOBAL MEAN= 272.21
(b)
Version 4
GLOBAL MEAN= 275.49
(c)
Version 5 Medium
GLOBAL MEAN= 273.74
(d)
Version 5 Tight
GLOBAL MEAN= 276.58

# Forecast Impact Tests

Experiments run with GSFC GEOS-5 data assimilation system

Forecasts run at 0.5° x 0.625° resolution

Data assimilation done using NCEP GSI analysis at 0.5° x 0.625° resolution

Control uses all data NCEP used operationally at that time

Assimilates all satellite data but AIRS, including Aqua AMSU radiances

Radiance assimilation includes observed AIRS radiances

Only radiances thought to be un-cloud contaminated are assimilated

Control + AIRS adds V5.0 global quality controlled T(p) retrievals

Assimilated as if radiosonde data

$\delta T(p)$ is used as the measurement error

27 independent forecasts run from each analysis

Forecasts verified against NCEP analysis

# Experiment 1: Assessment of Trade-Off of Spatial Coverage and Overall Accuracy

We compared forecasts from four assimilations over the period January 1, 2003 to January 31, 2003

1a Control

1b Radiance

1c AIRS V5 T(p) Standard QC

1d AIRS V5 T(p) Tight QC

AIRS temperatures are assimilated down to $p_{best}$

Data assimilated in both AIRS experiments is otherwise identical, except for $p_{best}$

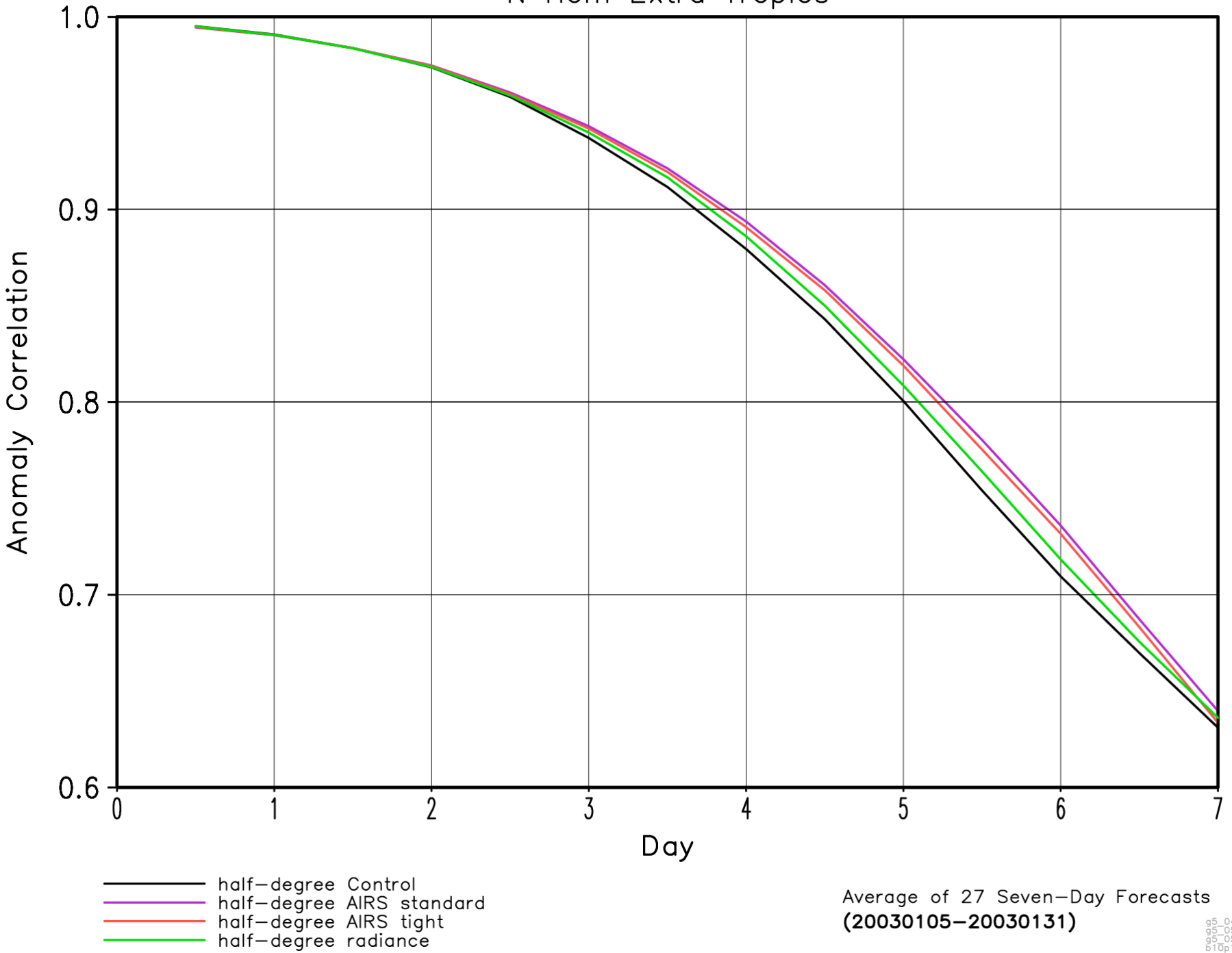
Accuracy judged against anomaly correlation of 7 day forecasts vs. NCEP analysis

An anomaly correlation of 1.0 represents a perfect forecast

An anomaly correlation of 0.6 is the lower bound of a useful forecast

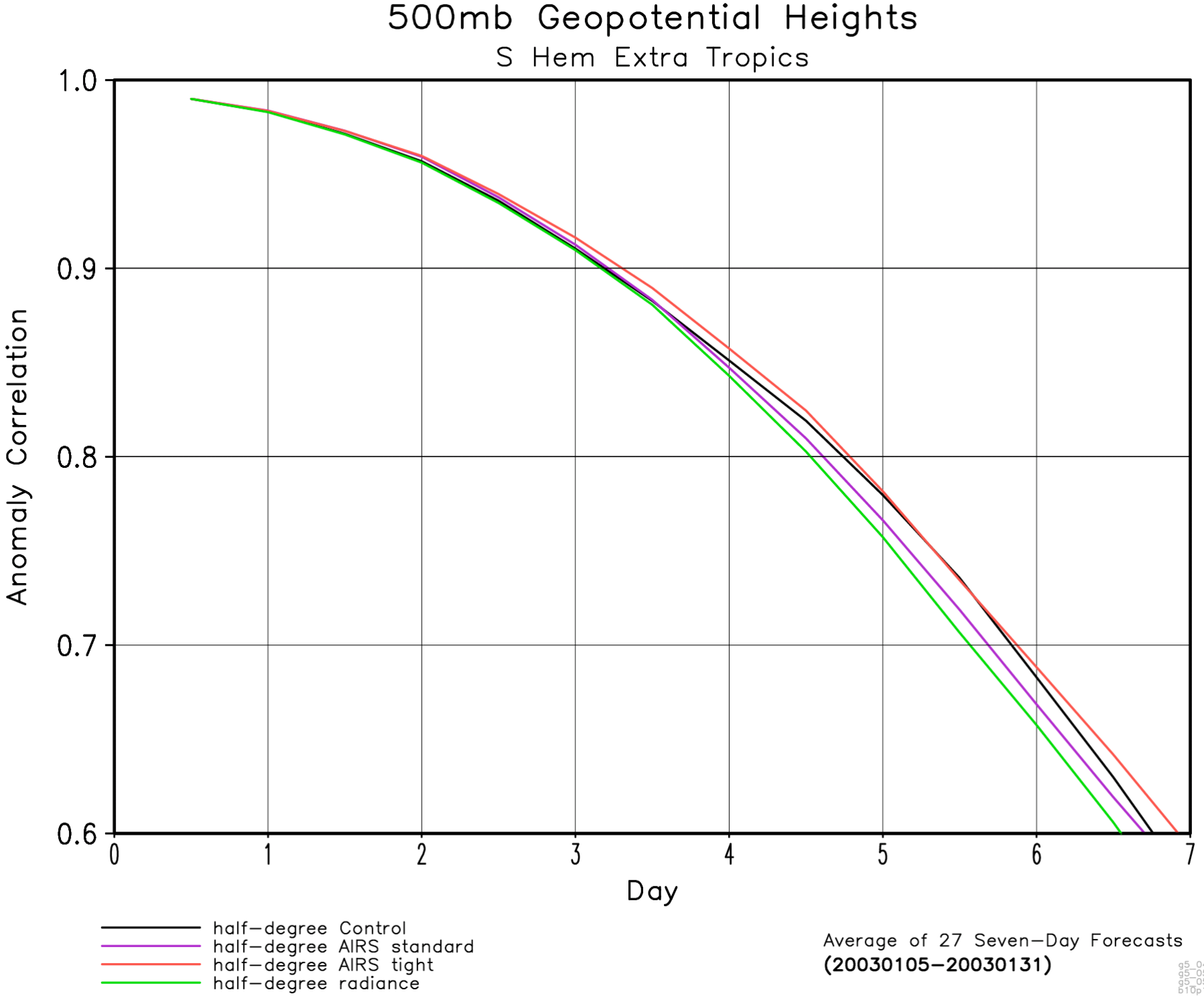
# 500mb Geopotential Heights

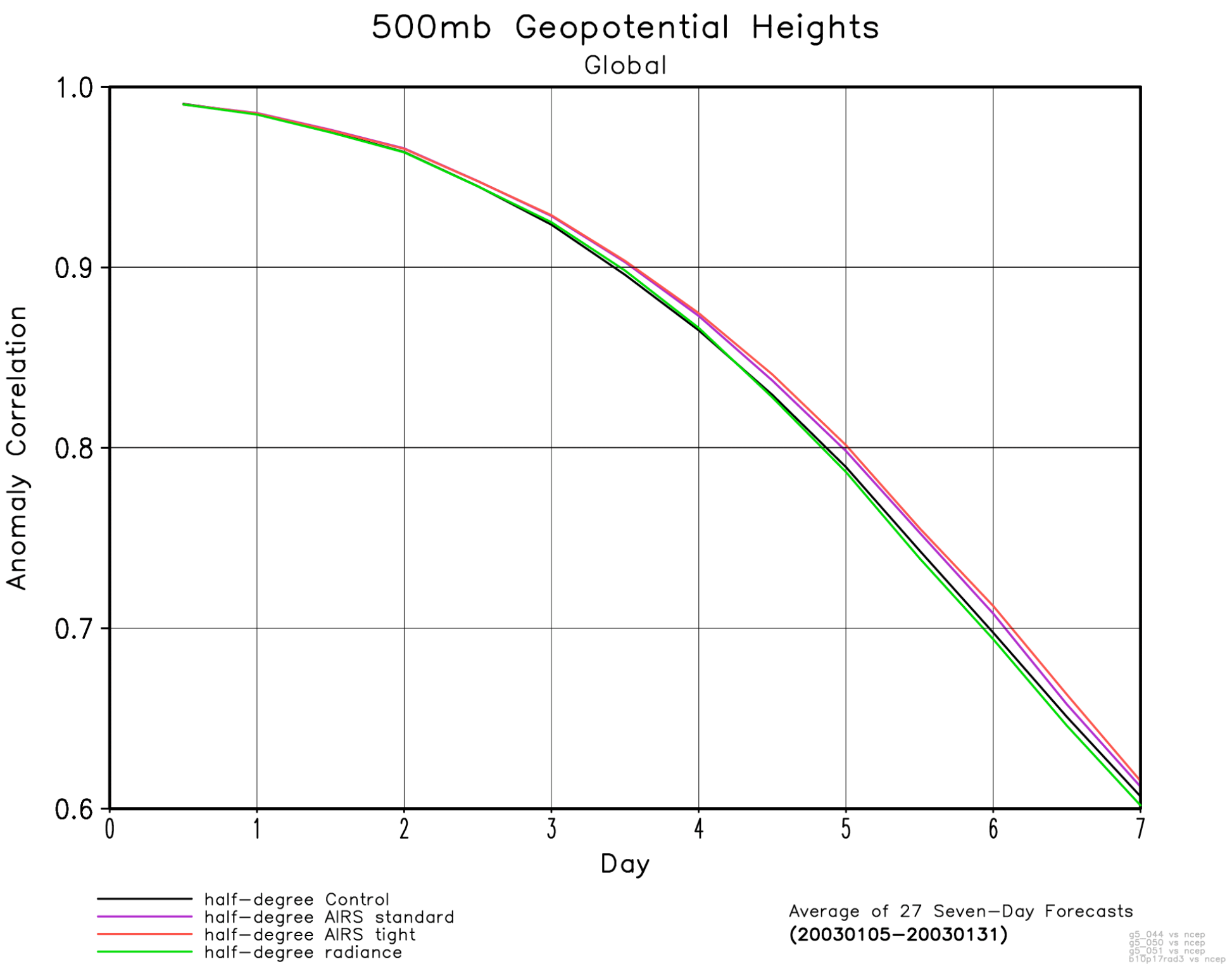
## N Hem Extra Tropics




Average of 27 Seven-Day Forecasts
**(20030105-20030131)**

g5_044 vs ncep
g5_050 vs ncep
g5_051 vs ncep
b10p17rad3 vs ncep


500mb Geopotential Heights
S Hem Extra Tropics
Anomaly Correlation
1.0
0.9
0.8
0.7
0.6
0
1
2
3
4
5
6
7
Day
half-degree Control
half-degree AIRS standard
half-degree AIRS tight
half-degree radiance
Average of 27 Seven-Day Forecasts
(20030105-20030131)
g5_044 vs ncep
g5_050 vs ncep
g5_051 vs ncep
b10p17rad3 vs ncep


500mb Geopotential Heights
Global
1.0
0.9
0.8
0.7
0.6
Anomaly Correlation
0
1
2
3
4
5
6
7
Day
half-degree Control
half-degree AIRS standard
half-degree AIRS tight
half-degree radiance
Average of 27 Seven-Day Forecasts
(20030105-20030131)
g5_044 vs ncep
g5_050 vs ncep
g5_051 vs ncep
b10p17rad3 vs ncep

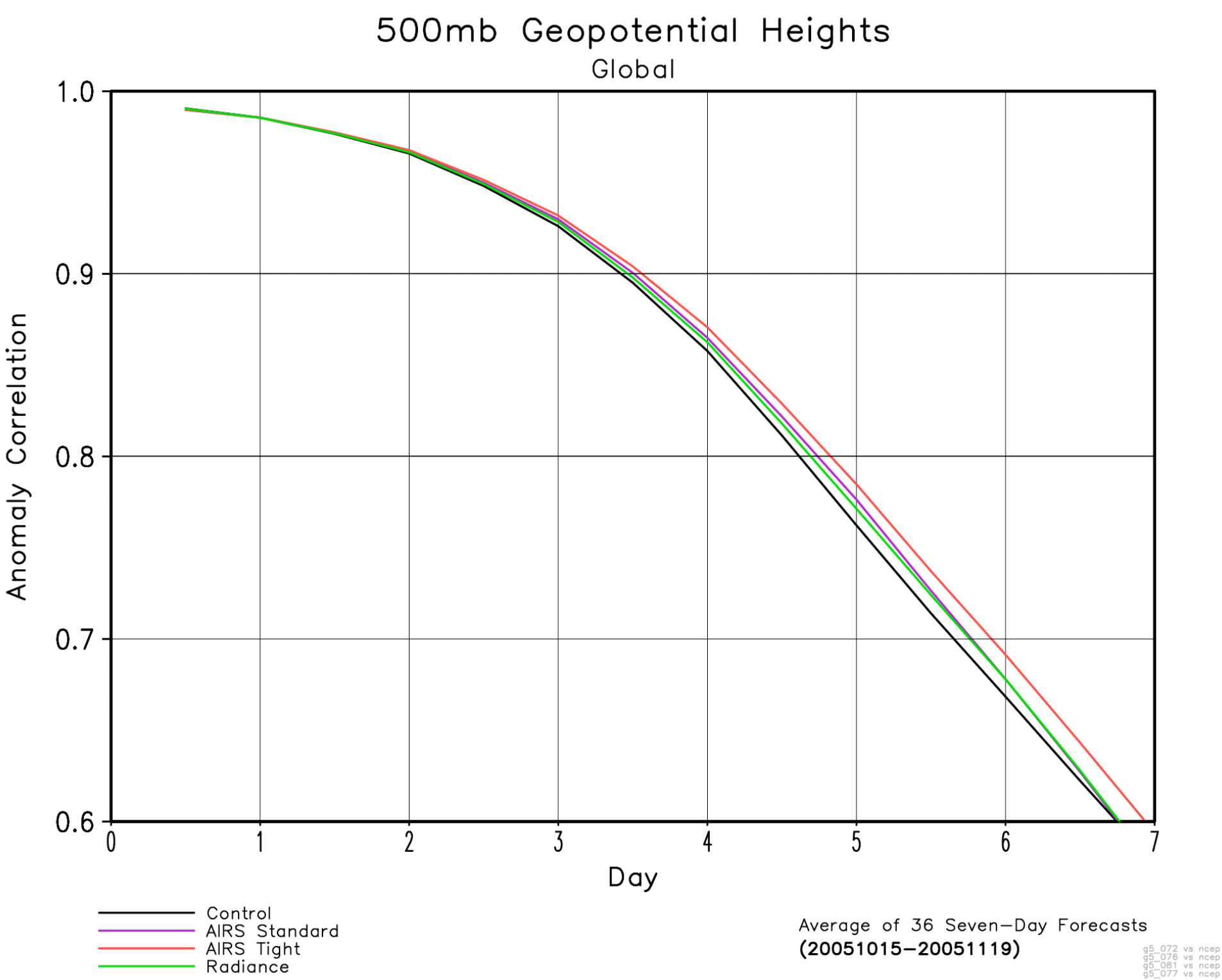
# Data Assimilation Experiments at Later Time Periods

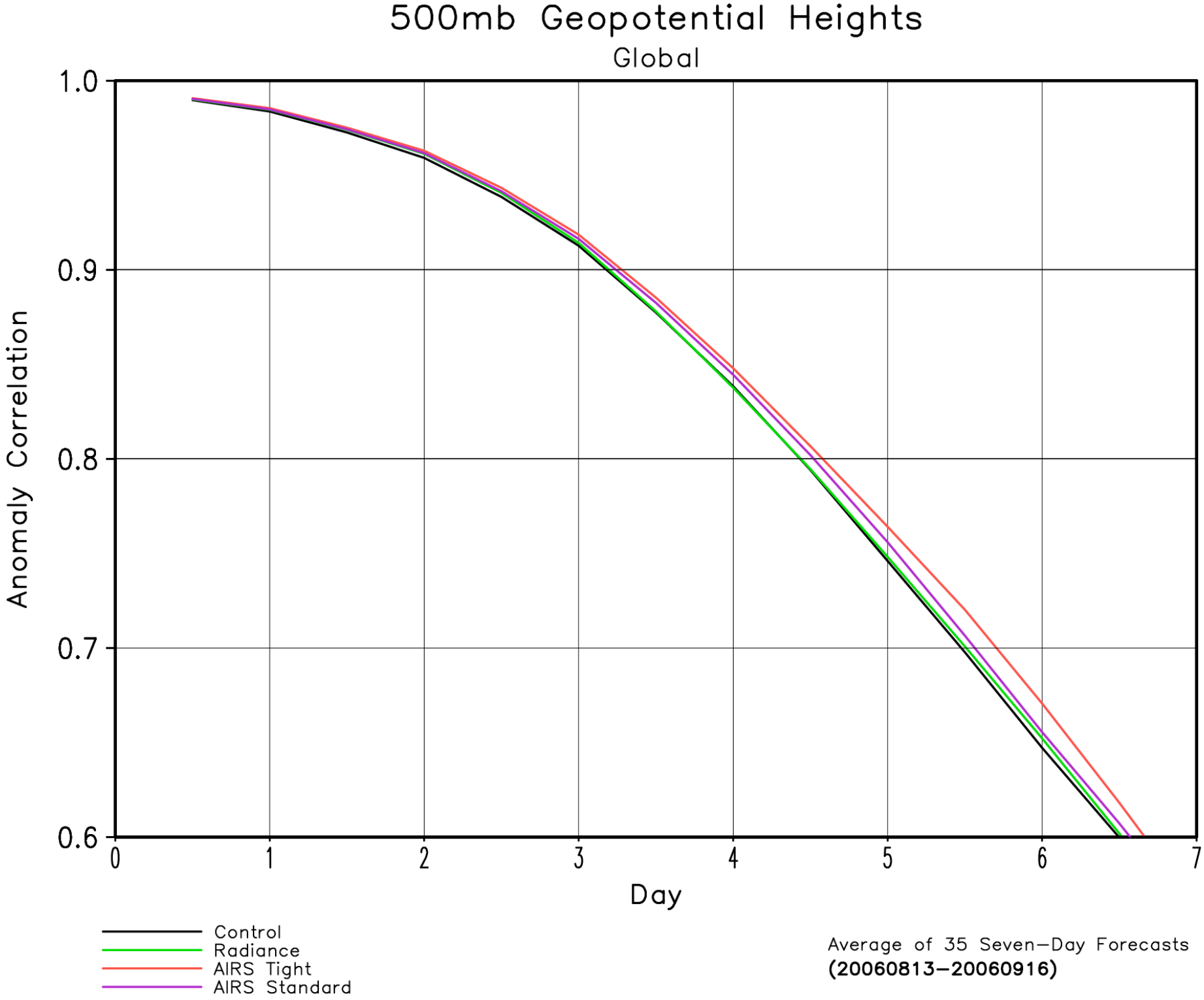
Analogous experiments were conducted in different seasons and later time periods

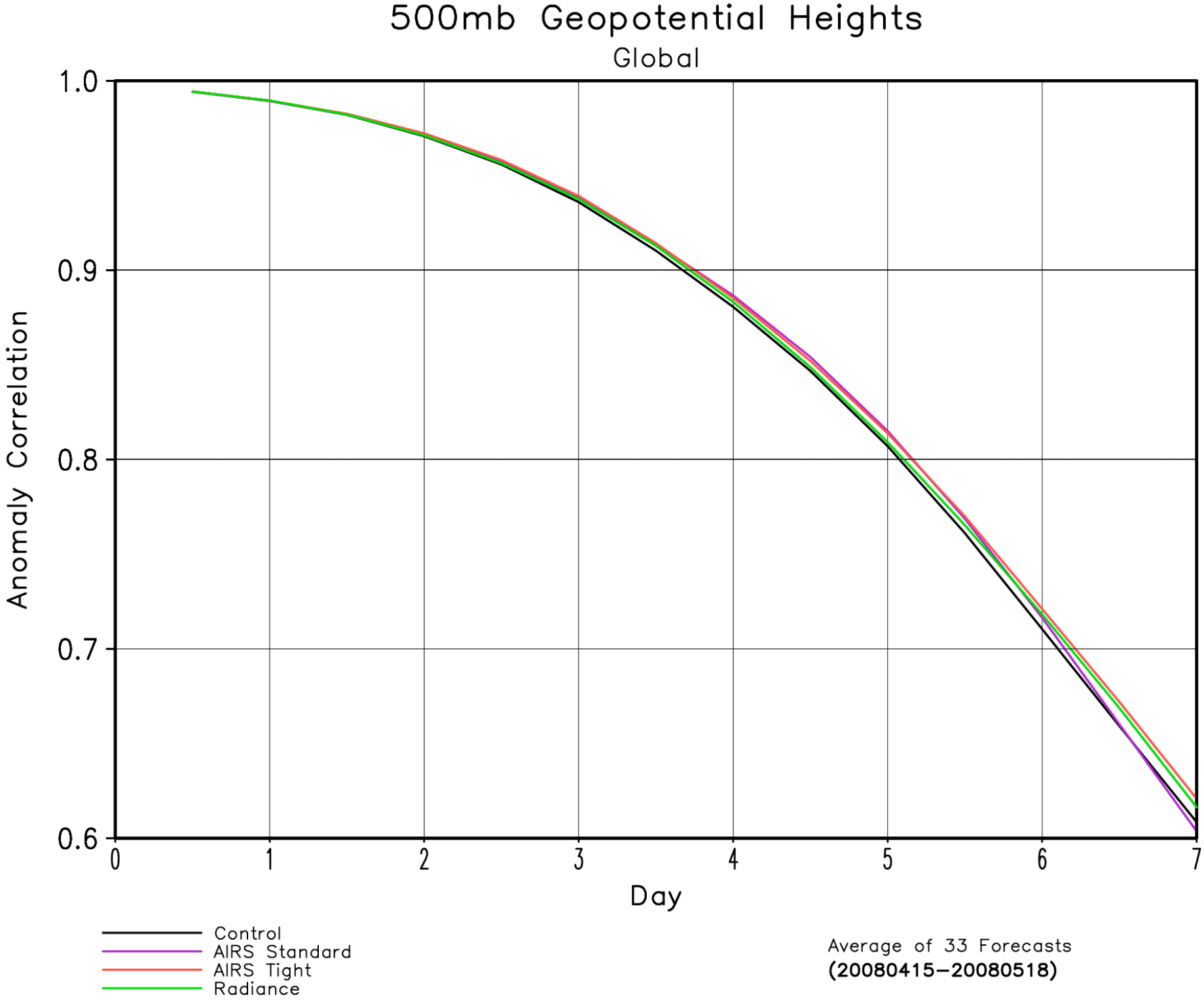
The objective was to see if improved forecasts continue to be obtained assimilating QC Controlled AIRS T(p) under different conditions

1) Northern Hemisphere Fall October 15 – November 19, 2005
2) Northern Hemisphere Summer August 10 – September 16, 2006
3) Northern Hemisphere Spring April 15 – May 18, 2008

All experiments were performed with Control, AIRS Standard, AIRS Tight, and Radiance Assimilation


500mb Geopotential Heights
Global
1.0
0.9
0.8
0.7
0.6
Anomaly Correlation
0
1
2
3
4
5
6
7
Day
Control
AIRS Standard
AIRS Tight
Radiance
Average of 36 Seven-Day Forecasts
(20051015-20051119)
g5_072 vs ncep
g5_076 vs ncep
g5_081 vs ncep
g5_077 vs ncep


500mb Geopotential Heights
Global
1.0
0.9
0.8
0.7
0.6
Anomaly Correlation
0
1
2
3
4
5
6
7
Day
Control
Radiance
AIRS Tight
AIRS Standard
Average of 35 Seven-Day Forecasts
(20060813-20060916)


500mb Geopotential Heights
Global
1.0
0.9
0.8
0.7
0.6
Anomaly Correlation
0
1
2
3
4
5
6
7
Day
Control
AIRS Standard
AIRS Tight
Radiance
Average of 33 Forecasts
(20080415–20080518)

# Summary

Data assimilation experiments were done at GSFC using GEOS-5 DAS at 0.5° x 0.625° resolution

Four years, four seasons

Assimilation of Quality Controlled AIRS Version 5 T(p) significantly improves Global 7 day forecast skill in each experiment

Tight QC performs significantly better than Standard Version 5 QC

QC methodology continues to work well at least until 2008

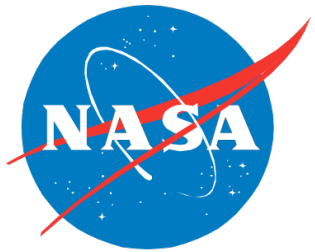
Assimilation of observed AIRS radiances as done operationally performed significantly poorer than assimilation of Quality Controlled T(p)

Lou Uccellini, Director of NCEP, is particularly impressed with these results

Tsengdar Lee, HQ Weather Data Analysis Program Scientist, is arranging to have NCEP operational data assimilation system to be made executable at GSFC

We will run analogous experiments using NCEP operational system at GSFC to see if improvement in forecast skill assimilating Quality Controlled T(p) holds up

Goal is to see if this new Data Assimilation methodology can improve operational forecast skill


NASA